

Journal of Melittology

Bee Biology, Ecology, Evolution, & Systematics

The latest buzz in bee biology

No. 115, pp. 1–6

8 February 2024

Daily activity rhythm of the African stingless bee *Hypotrigona gribodoi* (Hymenoptera: Meliponini) in the dry season, with notes on nest structure and colony composition

Prince E. Asante¹ & Christopher K. Starr^{1,2}

Abstract. We studied 18 colonies of *Hypotrigona gribodoi* (Magretti) nesting in the tubing of a disused horticultural sprinkler system during the late dry season in Ghana, West Africa. Flight activity began around dawn (about 06:00), rising to a peak in the half-hour starting 07:30 and gradually declining to end around dusk (about 18:00). Bees returning with pollen showed a more extended peak from 07:30 to 09:00. Dissection of 18 nests showed a mean inner volume of 466.5 ml, while 17 active colonies had a mean number of 851 adults. Colony size is positively correlated with nest size. It is likewise positively correlated with the fraction of fully mature adult females. Several nests had branching entrance tubes with an angle of roughly 30° between branches. In each of three such nests studied, there was a marked division in the use of the two branches, such that one served mainly as an exit and the other as an entrance.

INTRODUCTION

Hypotrigona gribodoi (Magretti) is one of 31 known species of stingless bees (Apiidae: Meliponini) in Africa (Pauly & Vereecken, 2013). It is found throughout the greater part of sub-Saharan Africa, where it can be locally abundant (Eardley, 2004). This and other species of *Hypotrigona* Cockerell have been the subject of numerous studies of aspects of nesting biology (Bassindale, 1955; Darchen, 1972, 1973, 1977, 1985; Darchen & Delage-Darchen, 1971; Keeping *et al.*, 1982; Kirchner & Friebe, 1999; LeThomas *et al.*, 1988; Lobreau-Callen *et al.*, 1990; Moritz & Crewe, 1988; Pooley & Michener, 1969). *Hypotrigona* spp. are known to nest in a variety of cavities, many of them irregular and/or very narrow. It is suggested that building cells in clusters, rather than combs, in many stingless bees is an adaptation to utilizing such constrained nesting spaces (Melo, 2021; Michener, 2007).

¹ Department of Zoology, University of Ghana, P.O. Box 67, Legon, Ghana.

² Caura Village, Trinidad & Tobago (ckstarr@gmail.com).

doi: <https://doi.org/10.17161/jom.i115.16251>

Bassindale (1955: fig. 2) described five relative ages of adult females in this species according to the relative lengths of the forewing and gaster and the pigmentation of the body, inferring that these form a maturation series, rather than polymorphism. Stage 5 seems most distinct in Bassindale's description, having the gaster shorter than the forewings and the head, thorax and terga black throughout. These are the outside workers that forage and stand guard at the nest entrance. Without exactly determining the durations of the different stages, his observations of two lab colonies suggested that stage 1 lasts only about three days and that stage 5 is especially long-lasting.

Here we report on the daily activity schedule, colony composition and some aspects of the nest of *H. gribodoi*. Part of our results have to do with a significant minority of nests with forked entrance tubes, such that bees departing or returning have a binary choice between the two branches. Nests with double entrances have been noted as an occasional phenomenon in several social wasps (Starr, 1989; White & Starr, 2013; J.W. Wenzel, pers. comm.) and various stingless bees (Roubik, 2006). The wasps were shown preferentially to treat one hole as an exit and the other as an entrance in the two colonies where this was studied (Starr, 1989; White & Starr, 2013).

MATERIAL AND METHODS

Our study site was the Botanical Garden of the University of Ghana (5°36'N 0°11'W), with all observations in February–March 2001 toward the end of the December–March dry season. By the end of our study there had been virtually no rain in the previous 10 weeks. In the long plastic tubes of an old irrigation system running horizontally overhead in a disused greenhouse, we found 19 *H. gribodoi* nests, all but one occupied by active colonies. The tubes had a uniform inner diameter of 2.9 cm, hence an inner cross-sectional area of 6.5 cm². The many sprinkler holes in the tubing were sealed by cerumen except for those few serving as nest entrances. An entrance tube projected from each entrance hole.

We studied the daily flight rhythm in eight colonies. Using mechanical counters, we recorded during 15 min of each half-hour period the number of a) departures, b) arrivals with pollen in the pollen baskets, and c) arrivals without pollen.

In order to study internal nest structure and colony size, we first sealed all entrance holes in three long tubes in the early nighttime, when all workers were presumably present. We then froze the tubes overnight in a cold-room at -15° C. After thawing the tubes for several hours, we cut them open along their length. Nest length was shown by the separations at each end.

A preliminary examination showed very few males in any colony. Because the total number of adults amounted to some thousands, in recording colony size we allowed ourselves to count females and males together without taking the time to sex them. However, in determining proportions of adults of different ages, we examined a haphazard sample of 100 females from each of 15 colonies and assigned them to stages according to Bassindale's (1955) scheme.

At three colonies with branched entrance tubes we recorded departures and arrivals at each branch. At each each nest we first counted 25 events (departures or arrivals) at one branch, then 25 at the other branch, for seven replicates (175 events at each branch).

A sample of adult females from this study is deposited in the National Museum of Natural History in Washington, DC, catalogued as USNM no. 1640099, accession no. 2087443.

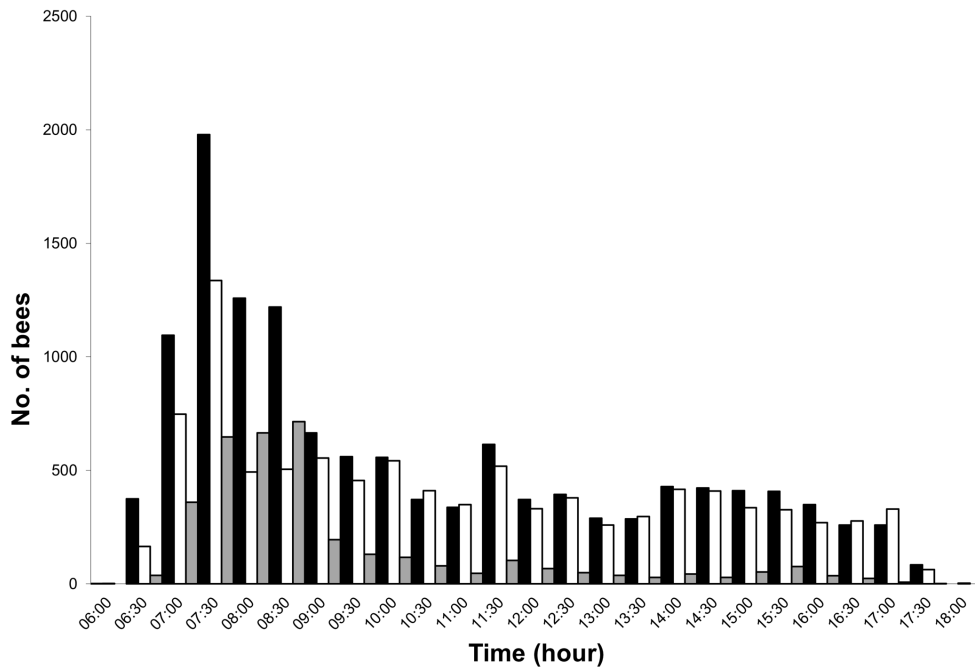


Figure 1. Numbers of bees departing from the nest (black) and returning throughout daylight hours. Returning bees are separated into those without (white) and with (gray) loaded pollen baskets

RESULTS

Flight activity commenced very soon after dawn and ended around dusk, with a peak in the 07:30–08:00 period (Fig. 1). However, the peak of bees returning with pollen extended for about an hour after this period.

The opened tubing was shown to enclose 19 nests with a mean±SD length of 71.3±40.6 cm (range 26.0–185.1 cm), hence a mean volume of 466.5 ml (range 170.2–1211.5 ml) (Table 1). Nest length was set by the bees at each end by a hard barrier containing sand. Of these, 18 harboured live colonies with a mean of 850.9 (range 243–1856) adults (Table 1). Colony size, expressed as number of adults, was positively correlated with nest volume (Spearman's rho 2-tailed test, $p=0.032$). In a sample of adult bees from 15 colonies, 44% were at Bassindale's stage 5, fully mature (Table 2). The fraction of stage-5 bees was positively correlated with colony size (Spearman's rho 2-tailed test, $p=0.016$).

Based on some hundreds of each cell type, brood cells and the slightly larger food-storage cells were each in clusters. Among the latter, pollen cells were usually located close to the entrance, while honey cells were further away. We noted a very few instances of honey cells within clusters of pollen cells.

Entrance tubes were round with a diameter close to 8–9 mm throughout. They varied in length from 8 to 23 cm. Of a total of 38 active nets in and near our study site, six had branched entrance tubes. In each of these, the division was some centimeters from the base of the tube, with each branch extending for several centimeters. We were able to observe the origin of the fork in one nest. Over several days the bees opened a new hole near the end of the entrance tube and then extended it to form a

Table 1. Nest volume and adult composition of 18 colonies of *Hypotrigona gribodoi* (Magretti). Further explanation in text.

Nest	Volume (ml)	Total adults	% adult females at stage 5
B	734.3	841	42
C	183.3	243	50
E	646.0	962	47
F	307.6	531	36
G	261.8	383	30
I	170.2		
L	750.1	1312	46
M	397.3	1003	55
N	468.6	481	40
O	747.4	1154	54
P	506.6	356	30
Q	291.9	779	
R	416.3	833	
S	1211.5	1856	58
T	346.9	879	42
U	328.6	734	36
V	433.3	812	49
W	196.4	1306	43
mean	466.5	850.9	43.9

new branch at an angle of roughly 30° from the original tube.

In our observations of activity at branched entrance tubes, the total number of bees departing was modestly greater than the number returning and entering each nest (Table 3). This is presumably due to inhibition of returning bees by the observer or disorientation due to a large unfamiliar object near the nest. Much more striking is the very strong bias in the use of the two branches, such that one is treated mainly as an entrance, the other as an exit. The differences are highly significant at each nest ($\chi^2 = 71.5, 50.5, \text{ and } 40.7$, respectively; $p < 0.001$).

DISCUSSION

The pattern of foraging activity throughout the day with a peak early in the morning is typical of non-parasitic diurnal bees in the lowland tropics (Roubik 1989).

The positive correlation of nest volume with colony size shows that the bees de-

Table 2. Numbers of adult females of *Hypotrigona gribodoi* (Magretti) in each of five age stages determined according to Bassindale (1955). Figures are means with ranges in brackets from samples of 100 bees from each of 15 colonies.

Stage 1	Stage2	Stage 3	Stage 4	Stage 5	Total
1.9 (0-10)	26.0 (10-51)	11.9 (6-21)	16.2 (5-27)	43.9 (30-58)	100

Table 3. Differential use of branches in forked nest entrances in three *Hypotrigona gribodoi* (Magretti) colonies. Branches are numbered arbitrarily. Further explanation in text.

	Branch 1	Branch 2	Total
Colony J			
Arrivals	43	122	165
Departures	132	53	185
Colony K			
Arrivals	41	113	154
Departures	134	62	196
Colony P			
Arrivals	45	104	149
Departures	130	71	201

molish and reconstruct the end barriers as the colony grows. It bears mention that the end plates were not made of very hard batumen, which the bees probably could not dismantle.

Our results on relative numbers of females at Bassindale's (1955) five maturation stages are consistent with his suggestion that stage 1 is exceptionally short and stage 5 probably of long duration (Table 2). However, in the absence of comparable results from other seasons the possibility remains that the fraction of stage-5 females was inflated by lower brood production during the dry season.

Pooley & Michener (1969) recorded a single branched entrance tube in an *H. gribodoi* nest in South Africa. No comparable observation is found in the several other papers on nest structure in this genus. However, this may simply mean that occasional forked tubes were treated as irrelevant anomalies. The significant minority of nests with nests with forked tubes in our population suggests that this is fairly common and may have an effect on ventilation (Moritz & Crewe, 1988) and/or facilitating movement at the nest entrance.

ACKNOWLEDGEMENTS

We thank Mary Yankson and Francis Yirenyki for access to the study site and other facilitation, Joshua Spiers for a graphic assist, and Claus Rasmussen and an anonymous reviewer for criticism leading to improvements.

REFERENCES

- Bassindale, R. 1955. The biology of the stingless bee *Trigona (Hypotrigona) gribodoi* Magretti (Meliponidae). *Proceedings of the Zoological Society of London* 125: 49–62.
- Darchen, R. 1972. Ethologie comparative de l'économie des matériaux de constructions chez divers apides sociaux, *Apis*, *Trigona* et *Melipona* (Apidés). *Revue de Comportement Animal* 6: 201–215.
- Darchen, R. 1973. La thermorégulation et l'éthologie de quelques espèces d'abeilles sociales d'Afrique (Apidae, Trigonini et *Apis mellifica* var. *adansonii*). *Apidologie* 4: 341–370.
- Darchen, R. 1977. L'essaimage chez les hypotrigones au Gabon. Dynamique de quelques populations. *Apidologie* 8: 33–59.
- Darchen, R. 1985. Les abeilles sociales d'une savane de Côte d'Ivoire. Ecologie du genre *Hypotrigona*. *Publications Scientifiques Accélérées* 7: 1–17.

- Darchen, R., & B. Delage-Darchen. 1971. Le déterminisme des castes chez les Trigones (Hyménoptères Apidés). *Insectes Sociaux* 18: 121–134.
- Eardley, C.D. 2004. Taxonomic revision of the African stingless bees (Apoidea: Apidae: Apinae: Meliponini). *African Plant Protection* 10: 63–96.
- Keeping, M.G., R.M. Crewe, & B.I. Field. 1982. Mandibular gland secretions of the Old World stingless bee *Trigona gribodoi* Magretti: Isolation, identification, and compositions changes with age. *Journal of Apicultural Research* 21: 65–73.
- Kirchner, W.H., & R. Friebe. 1999. Nestmate discrimination in the African stingless bee *Hypotrigona gribodoi* Magretti (Hymenoptera: Apidae). *Apidologie* 30: 293–298.
- LeThomas, A., D. Lobreau-Callen, B. Delage-Darchen, & R. Darchen. 1988. Analyse comparative des ressources polliniques et des stratégies de butinage de trois espèces de trigones s.l. en Côte d'Ivoire. *Institut Français de Pondichéry, Travaux de la Section des Sciences Techniques* 25: 345–354.
- Lobreau-Callen, D., A. LeThomas, B. Darchen, & R. Darchen. 1990. Quelques facteurs déterminant le comportement de butinage d'*Hypotrigona pothieri* (Trigonini) dans la végétation de Côte-d'Ivoire. *Apidologie* 21: 69–83.
- Melo, G.A.R. 2021. Stingless bees (Meliponini). In: Starr, C.K. (Ed.), *Encyclopedia of Social Insects*: 883–900. Springer; Cham, Switzerland; xxvi+1049 pp.
- Michener, C.D. 2007. *The Bees of the World* [2nd Edition]. Johns Hopkins University Press; Baltimore, MD; xvi+[i]+953 pp., +20 pls.
- Moritz, R.F.A., & R.M. Crewe. 1988. Air ventilation in nests of two African stingless bees, *Trigona denoiti* and *Trigona gribodoi*. *Experientia* 44: 1024–1027.
- Pauly, A., & N. Vereecken. 2013. Les Meliponinae africaines. <http://www.atlashymenoptera.net/page.aspx??ID=121>
- Pooley, A.C., & C.D. Michener. 1969. Observations on nests of stingless honeybees in Natal (Hymenoptera: Apidae). *Journal of the Entomological Society of Southern Africa* 32: 423–430.
- Roubik, D.W. 1989. *Ecology and Natural History of Tropical Bees*. Cambridge University Press; Cambridge, UK; 514 pp.
- Roubik, D.W. 2006. Stingless bee nesting biology. *Apidologie* 37: 124–143.
- Starr, C.K. 1989. The ins and outs of a tropical social wasp nest. *Proceedings of the Entomological Society of Washington* 91: 26–28.
- White, S., & C.K. Starr. 2013. Comings and goings of *Agelaia multipicta* (Hymenoptera: Vespidae) in Trinidad, West Indies. *Living World (Port of Spain)* 2013: 59–60.



Journal of Melittology

A Journal of Bee Biology, Ecology, Evolution, & Systematics

The *Journal of Melittology* is an international, open access journal that seeks to rapidly disseminate the results of research conducted on bees (Apoidea: Anthophila) in their broadest sense. Our mission is to promote the understanding and conservation of wild and managed bees and to facilitate communication and collaboration among researchers and the public worldwide. The *Journal* covers all aspects of bee research including but not limited to: anatomy, behavioral ecology, biodiversity, biogeography, chemical ecology, comparative morphology, conservation, cultural aspects, cytogenetics, ecology, ethnobiology, history, identification (keys), invasion ecology, management, melittopalynology, molecular ecology, neurobiology, occurrence data, paleontology, parasitism, phenology, phylogeny, physiology, pollination biology, sociobiology, systematics, and taxonomy.

The *Journal of Melittology* was established at the University of Kansas through the efforts of Michael S. Engel, Victor H. Gonzalez, Ismael A. Hinojosa-Díaz, and Charles D. Michener in 2013 and each article is published as its own number, with issues appearing online as soon as they are ready. Papers are composed using Microsoft Word® and Adobe InDesign® in Lawrence, Kansas, USA.

Interim Editor

Victor H. Gonzalez
University of Kansas

Assistant Editors

Victor H. Gonzalez
University of Kansas

Claus Rasmussen
Aarhus University

Cory S. Sheffield
Royal Saskatchewan Museum

Founding Editor & Editor Emeritus

Michael S. Engel
University of Kansas

Journal of Melittology is registered in ZooBank (www.zoobank.org), and archived at the University of Kansas and in Portico (www.portico.org).

<http://journals.ku.edu/melittology>
ISSN 2325-4467